$$I = \frac{V}{R + j\omega L + \frac{1}{j\omega C}} \qquad \omega L = \frac{1}{\omega C} \qquad \omega_0^2 = \frac{1}{LC} \qquad \omega_0 = \frac{1}{\sqrt{LC}}$$

1

$$I = \frac{|V|}{R} \qquad \varphi = \sum_i \varphi_{zi} - \sum_i \varphi_{pi} = k\pi$$

$$R + sL + \frac{1}{sC} = 0 \qquad s^2 LC + sRC + 1 = 0$$

$$\cancel{s = \frac{-RC \pm \sqrt{R^2C^2 - 4LC}}{2LC} = -\frac{R}{2L} \pm \frac{R}{2L}\sqrt{1 - \frac{4L}{R^2C^2}}}$$

$$s^2 + s\frac{R}{L} + \frac{1}{LC} = 0$$

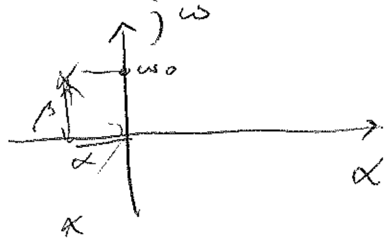
$$s_{1,2} = -\frac{R}{2L} \pm \frac{1}{2}\sqrt{\frac{R^2}{L^2} - \frac{4}{LC}} = -\frac{R}{2L} \pm j\sqrt{\frac{1}{LC} - \frac{1}{4}\left(\frac{R}{L}\right)^2}$$

$\omega_0^2$

$$s_{1,2} = -\frac{R}{2L} \pm j\omega_0\sqrt{1 - \frac{1}{4}\left(\frac{R}{L\omega_0}\right)^2} \qquad Q = \frac{L\omega_0}{R}$$

$$s_{1,2} = -\frac{R}{2L} \pm j\omega_0\sqrt{1 - \frac{1}{4Q^2}} \qquad Q \gg 1$$

$$s_{1,2} = \underbrace{-\frac{R}{2L}}_{\alpha} \pm \underbrace{j\omega_0}_{\beta} \qquad \frac{\beta}{2\alpha} = \frac{\omega_0 L}{R} = Q$$



2

$$I = \frac{V}{\sqrt{R^2 + \omega^2\left(L - \frac{1}{\omega^2 C}\right)^2}} =$$

$$= \frac{V}{\sqrt{R^2 + \omega^2 L^2\left(1 - \frac{\omega_0^2}{\omega^2}\right)^2}} = \frac{V}{R\sqrt{1 + \frac{\omega^2 L^2}{R^2}\left(1 - \frac{\omega_0^2}{\omega^2}\right)^2}}$$

$$2 = 1 + \frac{\omega_{dB}^2 L^2}{R^2}\left(1 - \frac{\omega_0^2}{\omega_{dB}^2}\right)^2$$

$$\left(1 - \frac{\omega_0^2}{\omega_{-3dB}^2}\right)^2 = \frac{R^2}{\omega_{-3dB}^2 L^2}$$

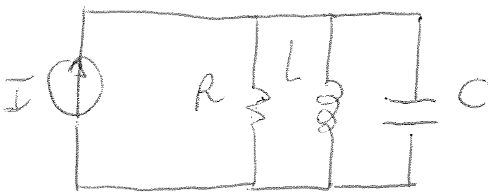
$$\frac{(\omega_{-3dB}^2 - \omega_0^2)}{\omega_{-3dB}} = \frac{R}{\omega_{-3dB} L}$$

$$\frac{(\omega_{-3dB} + \omega_0)(\omega_{-3dB} + \omega_0)}{\omega_{-3dB}^2} = \frac{R}{\omega_{\cancel{-3dB}} L}$$

$$\frac{2\,\omega_0\,(\omega_{-3dB} - \omega_0)}{\omega_0^{\cancel{2}}} = \frac{R}{\omega_0 L}$$

$$\cancel{2(\omega_{-3dB} - \omega_0) = BW = \frac{R}{\omega_0^2 L} = \frac{Q}{\omega_0}}$$

$$\frac{BW}{\omega_0} = \frac{R}{\omega_0 L} = \frac{1}{Q} \qquad \frac{BW}{\omega_0} = \frac{1}{Q}$$




$$V = \frac{I}{\frac{1}{R} + \frac{1}{j\omega L} + j\omega C}$$

$\omega_0 \qquad \omega_0^2 = \frac{1}{LC} \qquad |V| = |I| R$

$$\frac{1}{R} + \frac{1}{sL} + sC = 0 \qquad s^2 LCR + R + sL = 0$$

$L$

$$s^2 LC + s\frac{L}{R} + 1 = 0$$

$$s_{1,2} = -\frac{1}{2RC} \pm \frac{1}{2LC}\sqrt{\left(\frac{L}{R}\right)^2 - 4LC} =$$

$$= -\frac{1}{2RC} \pm j\frac{1}{2LC}\sqrt{4LC - \left(\frac{L}{R}\right)^2} =$$

$$L = \frac{1}{\omega_0^2 C}$$

$$= -\frac{1}{2RC} \pm j\frac{2}{2LC}\sqrt{LC - \frac{1}{4}\left(\frac{L}{R}\right)^2} = \cancel{-\frac{1}{2RC} \pm j\frac{\sqrt{LC}}{LC}\sqrt{1 - \frac{1}{4}\left(\frac{\sqrt{LC}\,L}{RC\sqrt{LC}}\right)^2}}$$

$$= \cancel{-\frac{1}{2RC} \pm j\frac{1}{LC}\sqrt{LC\left(1 - \frac{1}{4}\frac{LC}{\omega_0^2 RC}\right)}}$$

$$= -\frac{1}{2RC} \pm j\frac{1}{LC}\sqrt{LC\left(1 - \frac{1}{4LC}\left(\frac{L}{R}\right)^2\right)} = -\frac{1}{2RC} \pm j\frac{\sqrt{LC}}{LC}\sqrt{1 - \frac{1}{4}\frac{L}{CR^2}} =$$

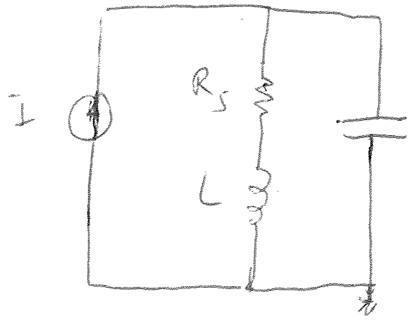
$$= -\frac{1}{2RC} \pm j\omega_0\sqrt{1 - \frac{1}{4}\frac{1}{\omega_0^2 C^2 R^2}} \qquad Q = \omega_0 CR$$

$$= -\frac{1}{2RC} \pm j\omega_0\sqrt{1 - \frac{1}{4Q^2}} \simeq -\frac{1}{2RC} \pm j\omega_0$$

$\beta = \omega_0$

$2\alpha = \frac{1}{RC}$

$$\frac{\beta}{2\alpha} = \omega_0 RC = Q$$




$$V = \frac{I}{j\omega C + \dfrac{1}{R_S + j\omega L}}$$

$R_S$ piccolo rispetto a $\omega L$ @ $\omega_0$

$$\omega_0^2 = \frac{1}{LC}$$

$$sC + \frac{1}{R_S + sL} = 0 \qquad sRC + s^2LC + 1 = 0$$

$$s^2LC + sRC + 1 = 0 \qquad s_{1,2} = -\frac{R\cancel{C}}{2L\cancel{C}} \pm \frac{1}{2LC}\sqrt{(RC)^2 - 4LC} =$$

$$= -\frac{R}{2L} \pm j\frac{1}{LC}\sqrt{\cancel{4}LC - \frac{(RC)^2}{4}} = -\frac{R}{2L} \pm j\frac{1}{LC}\sqrt{LC\left(1 - \frac{(RC)^2}{LC\,4}\right)}$$

$$\frac{1}{\omega_0^2}$$

$$\cancel{= -\frac{R}{2L} \pm j\omega_0\sqrt{1 - \frac{R^2C}{4L}} = \left\{C = \frac{\omega_0^2}{L}\right\} = -\frac{R}{2L} \pm j\omega_0\sqrt{1 - \frac{R^2\omega_0^2}{4L^2}}}$$

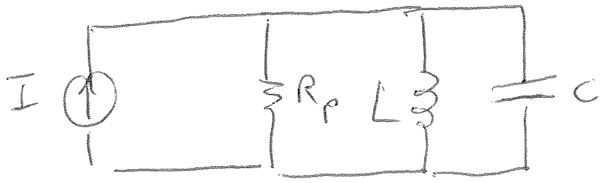
$$= -\frac{R}{2L} \pm j\omega_0\sqrt{1 - \frac{(\omega_0 RC)^2}{4}}$$

$$C = \frac{1}{\omega_0^2 L}$$

$$Q = \frac{1}{\omega_0 R_S C} = \frac{\omega_0 L}{R_S}$$

$$Q = \frac{1}{\omega_0 R_S C} \qquad Q = \omega_0 R_p C \qquad R_p = R_S Q^2$$

$$Q = \omega_0 R_S Q^2 C = \frac{\omega_0 R_S C}{\omega_0^2 R_S^2 C^2} = \frac{1}{\omega_0 R_S C}$$

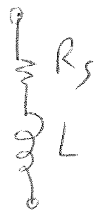



$V = I R_p = I R_S Q^2$

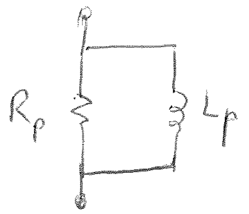
V molto elevata

Fattori di merito e perdite nei componenti

$$Q_{SL} = \frac{\omega_0 L}{R_S}$$




$$Z_{SL} = R_{SL} + j\omega L = j\omega L + \frac{\omega_0 L}{Q_{SL}}$$




$$Z = R_p /\!/ j\omega L_p = \frac{R_p \cdot j\omega L_p (R_p - j\omega L_p)}{(R_p + j\omega L_p)(R_p - j\omega L_p)} =$$

$$= \frac{\omega^2 L_p^2 R_p + j\omega L_p R_p^2}{R_p^2 + \omega^2 L_p^2} = \frac{j\omega L_p R_p^2}{R_p^2 + \omega^2 L_p^2} + \frac{\omega^2 L_p^2 R_p}{R_p^2 + \omega^2 L_p^2} =$$

$$= \frac{j\omega L_p \cancel{R_p^2}}{\cancel{R_p^2}\left(1 + \frac{\omega^2 L_p^2}{R_p^2}\right)} + \frac{\omega^2 L_p^2 R_p}{R_p^2\left(1 + \frac{\omega^2 L_p^2}{R_p^2}\right)}$$

$$Q_{pL}^2 = \frac{R_p^2}{\omega^2 L_p^2}$$

$$= \frac{j\omega L_p}{1 + \frac{1}{Q^2}} + \frac{R_p}{Q_{pL}^2\left(1 + \frac{1}{Q_{pL}^2}\right)}$$

$$Z_{sL} = Z_{pL} \qquad L_p = L\left(1+\frac{1}{Q_{pL}^2}\right) \simeq L$$

$$R_p = R_{sL}\, Q_{pL}^2 \left(1+\frac{1}{Q_{pL}^2}\right) \simeq R_{sL}\, Q_{pL}^2$$

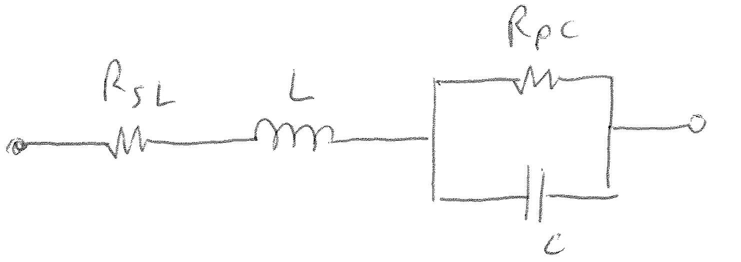
$$Q_{pL} = Q_{sL} = \frac{\omega L}{R_{sL}} = \frac{R_{pL}}{\omega L_p} = \frac{R_{pL}}{\omega L} = Q_L \qquad \begin{cases} Q_{pc} = \omega R_p C \\ Q_{sc} = \dfrac{1}{\omega R_s C} \end{cases}$$

$$R_s = \frac{R_p}{1+Q_{pc}^2} \qquad C_s = C\left(1+\frac{1}{Q_{pc}^2}\right)$$

CORR dei FATTORI DI MERITO

$$Q_L = \frac{\omega L}{R_{sL}} \qquad Q_c = \omega R_{pc} C$$

$$Q_L = \frac{R_{pL}}{\omega L} \qquad Q_c = \frac{1}{\omega R_s C}$$




$$Z = R_{sL} + j\omega L + \frac{R_{pc}}{1+j\omega R_{pc} C} = R_{sL} + j\omega L + \frac{R_{pc}(1-j\omega R_{pc} C)}{(1+j\omega R_{pc} C)(1-j\omega R_{pc} C)} =$$

$$= R_{sL} + j\omega L + \frac{R_{pc}}{1+\omega^2 R_{pc}^2 C^2} - \frac{j\omega R_{pc}^2 C}{1+\omega^2 R_{pc}^2 C^2}$$

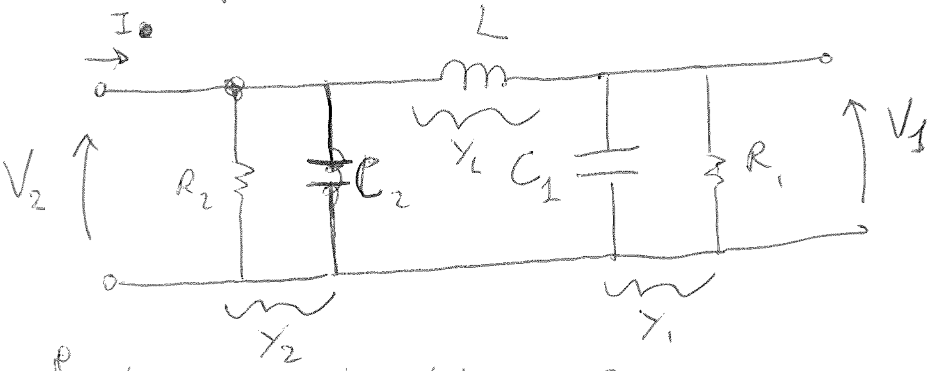
$$= \frac{\omega L}{Q_L} + \frac{R_{pc}\cdot \omega C}{\omega C(1+\omega^2 R_{pc}^2 C^2)} + j\omega L - \frac{j\,\omega^2 R_{pc}^2 C^2}{\omega C(1+\omega^2 R_p^2 C^2)} =$$

$$= \underbrace{\frac{\omega L}{Q_L} + \frac{Q_c}{\omega C(1+Q_c^2)}}_{R\ \text{serie}} + j\omega L - j\,\frac{Q_c^2}{\omega C(1+\omega^2 R_p^2 C^2)}$$

$$\frac{\omega L}{Q} = \frac{\omega L}{Q_L} + \frac{Q_c}{\omega C(1+Q_c^2)}$$

$$\frac{1}{Q} = \frac{1}{Q_L} + \frac{Q_c}{1+Q_c^2} \simeq \frac{1}{Q_L} + \frac{1}{Q_C}$$

Rete di Colpitts




$$\begin{cases} V_2 Y_2 + (V_2 - V_1) Y_L = I \\ (V_2 - V_1) Y_L - V_1 Y_1 = 0 \end{cases}$$

$$V_1(s) = \frac{I}{s^3 L C_1 C_2 + s^2 (L C_1 G_2 + L C_2 G_1) + s(C_1 + C_2 + L G_1 G_2) + G_1 + G_2}$$

$$s^3 + s^2 \frac{C_1 G_2 + C_2 G_1}{C_1 C_2} + s \frac{C_1 + C_2 + L G_1 G_2}{L C_1 C_2} + \frac{G_1 + G_2}{L C_1 C_2} = 0$$

$$a_3 s^3 + s^2 a_2 + s a_1 + a_0 = 0$$

$s_0, s_1, s_2,$

• freq. di risonanza

$$-j\omega^3 + j\omega\,\frac{C_1+C_2+LG_1G_2}{LC_1C_2} = 0$$

$$\omega_0^2 = \frac{C_1+C_2}{LC_1C_2} + \frac{G_1G_2}{C_1C_2} = \frac{1}{L\frac{C_1C_2}{C_1+C_2}} + \frac{1}{R_1C_1R_2C_2}$$

•
$$a_0 = -s_0 s_1 s_2 = \frac{G_1+G_2}{LC_1C_2} = -s_0|s_1|^2$$

$$s_0 = -\frac{G_1+G_2}{LC_1C_2}\cdot\frac{1}{\omega_0^2} \simeq -\frac{G_1+G_2}{LC_1C_2\cdot\frac{(C_1+C_2)}{LC_1C_2}} = -\frac{G_1+G_2}{C_1+C_2}$$

•
$$a_2 = -(s_1+s_2+s_0)$$

$$-(s_1+s_2) = -2\,\mathrm{Re}[s_1] = 2\alpha = s_0 + a_2 =$$

$$2\alpha = -\frac{G_1+G_2}{C_1+C_2} + \frac{C_1G_2+C_2G_1}{C_1C_2}$$

$$= \frac{-C_1C_2(G_1+G_2) + (C_1+C_2)C_1G_2 + (C_1+C_2)(C_2G_1)}{C_1C_2(C_1+C_2)} =$$

$$= -\frac{\cancel{C_1C_2}G_1 - C_1\cancel{C_2}G_2 + C_1^2G_2 + \cancel{C_1C_2G_2} + \cancel{C_1C_2}G_1 + C_2^2}{C_1C_2(C_1+C_2)}$$

$$2\alpha = \frac{C_1^2 G_2 + C_2^2 G_1}{C_1 C_2 (C_1 + C_2)} =$$

$$Q = \frac{\beta}{2\alpha} = \frac{\omega_0^2 C_1 C_2 (C_1 + C_2)}{C_1^2 G_2 + C_2^2 G_1} = \frac{\omega_0^2 C_1 C_2 (C_1 + C_2)}{\omega_0 C_1^2 \frac{1}{R_2} + \omega_0 C_2^2 \frac{1}{R_1}} =$$

$$= \frac{\omega_0^2 C_1 C_2 R_1 R_2 (C_1 + C_2)}{\omega_0 C_1 R_1 C_1 + \omega_0 C_2 R_2 C_2} = \frac{Q_{C_1} Q_{C_2} (C_1 + C_2)}{C_1 Q_{C_1} + C_2 Q_{C_2}} \simeq$$

$$C_1 >> C_2$$

$$Q_1 >> Q_2 \qquad \simeq \quad Q_{C_2}\left(1 + \frac{C_2}{C_1}\right) \simeq Q_{C_2}$$

$$V_1(\omega_0) = \frac{I}{-\omega_0^2 (L C_1 G_2 + L C_2 G_1) + G_1 + G_2}$$

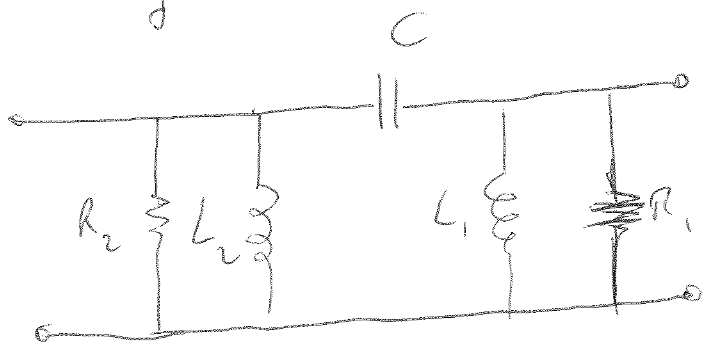
$$= -\frac{I}{(C_1 + C_2)\left(\frac{G_2}{C_2} + \frac{G_1}{C_1}\right) + \cancel{G_1} + \cancel{G_2}} = -\frac{I}{G_2 \frac{C_1}{C_2}}$$

$$V_1(\omega_0) = -I . R_2 \left(\frac{C_2}{C_1}\right)$$

$$R_{in}(\omega_0) = R_1 \left(\frac{C_1}{C_2}\right)^2 \Rightarrow V_2 \simeq I R_2$$

$$V_1 = -\frac{V_2}{R_2} R_2 \left(\frac{C_2}{C_1}\right) = -V_2 \frac{C_2}{C_1}$$

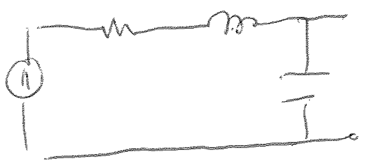
Hartley




Coeff. di stabilità

$$S_F = \omega_0 \left|\frac{d\varphi}{d\omega}\right|_{\omega=\omega_0}$$

Risonante serie



$$I = \frac{V}{R + j\omega L + \frac{1}{j\omega C}}$$

$$\varphi = -\text{arctg}\,\frac{b}{a} = -\text{arctg}\,\frac{\omega L - \frac{1}{\omega C}}{R} = -\text{arctg}\,\frac{\omega L\left(1-\frac{\omega_0^2}{\omega^2}\right)}{R}$$

$$\frac{d\varphi}{d\omega} = -\frac{1}{1+\left[\frac{\omega L\left(1-\frac{\omega_0^2}{\omega^2}\right)}{R}\right]^2}\cdot\left[\frac{L}{R}\left(1-\frac{\omega_0^2}{\omega^2}\right) + \frac{\omega L}{R}\cdot\frac{\omega_0^2}{\omega^4}2\omega\right]\Bigg|_{\omega=\omega_0}$$

$$= +\omega_0^2\,\frac{\omega_0 L}{R}\,\frac{2\omega_0}{\omega_0^4} = \frac{2L\omega_0^2}{R\omega_0^2} = \frac{2L}{R}$$

$$SF = \frac{\omega_0 2L}{R} = 2Q$$

$$SF = \omega_0 \left.\frac{d\varphi}{d\omega}\right|_{\omega=\omega_0}$$

$$V = \frac{I}{(s-s_0)(s-s_1)(s-s_2)}$$

$$V(j\omega) = \frac{I}{(j\omega - s_0)(j\omega - s_1)(j\omega - s_2)} = \frac{I}{(j\omega - s_0)(j\omega - \alpha - j\omega_0)(j\omega - \alpha + j\omega_0)}$$

$$SF = \omega_0 \left| \frac{d\varphi_0}{d\omega} + \frac{d\varphi_1}{d\omega} + \frac{d\varphi_2}{d\omega} \right|$$

$$\varphi_0 = \operatorname{arctg} \frac{\omega}{|s_0|} \qquad \frac{d\varphi_0}{d\omega} = \frac{1}{1 + \frac{\omega_0^2}{|s_0|^2}} \cdot \frac{1}{s_0} = \frac{s_0}{\omega_0^2}$$

$$\varphi_1 = \operatorname{arctg} \frac{\omega_0 + \omega}{\alpha} \qquad \frac{d\varphi_1}{d\omega} = \left.\frac{1}{1 + \left(\frac{\omega_0 + \omega}{\alpha}\right)^2} \cdot \frac{1}{\alpha}\right| = \frac{\alpha}{2\omega_0^2}$$

$$\varphi_2 = \operatorname{arctg} \frac{\omega_0 - \omega}{\alpha} \qquad \frac{d\varphi_2}{d\omega} = \frac{1}{1 + \left(\frac{\omega_0 - \omega}{\alpha}\right)^2} \cdot \frac{1}{\alpha} = \frac{1}{\alpha}$$

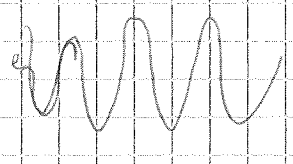
$$SF = \omega_0 \cdot \frac{1}{\alpha} = \frac{\omega_0}{\alpha} = \frac{\beta}{\alpha} = 2Q$$

- Oscillatori sinusoidali in assenza di segnale — conversione di ENERGIA

1

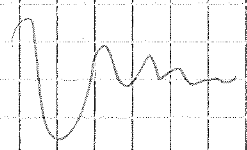
- $A_f(s) = \dfrac{A(s)}{1 + A(s) f(s)}$ $\qquad 1 + A(s) f(s) = 0$

$s_{1,2} = \sigma_0 \pm j\omega_0 \qquad \sigma_0 > 0$

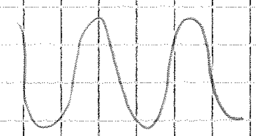


$2 e^{\sigma_0 t} \cos(\omega_0 t) \Rightarrow$

$\sigma_0 < 0$



$\sigma_0 = 0$



$s = j\omega \qquad 1 + f(j\omega) A(j\omega) = 0$

$$\begin{cases} Re\left[1 + f(j\omega) A(j\omega)\right] = -1 \\ Im\left[1 + f(j\omega) A(j\omega)\right] = 0 \end{cases}$$

- fig. 2.1

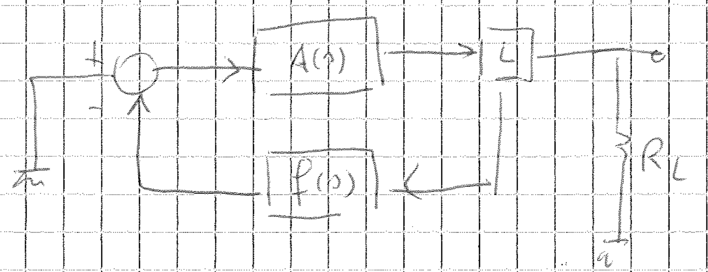
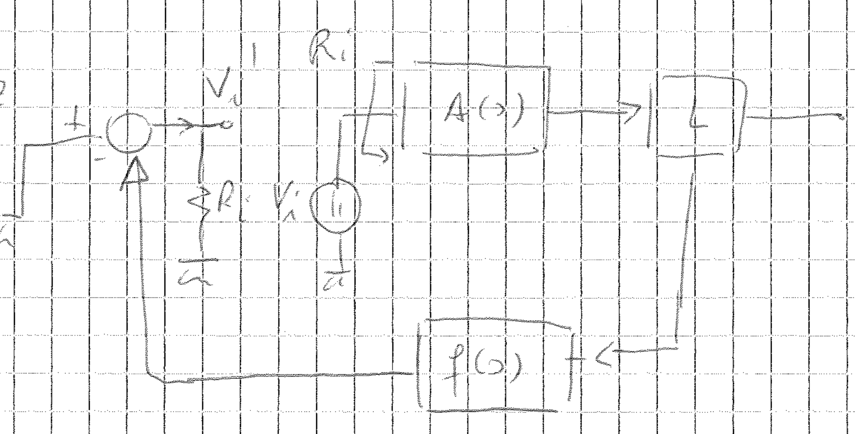


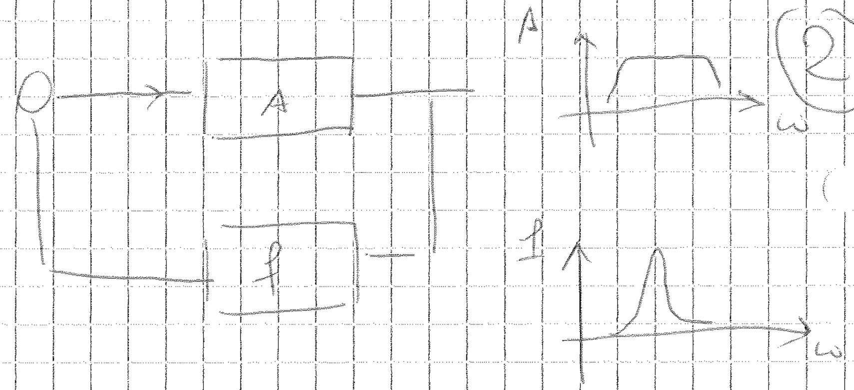

fig. 2.2



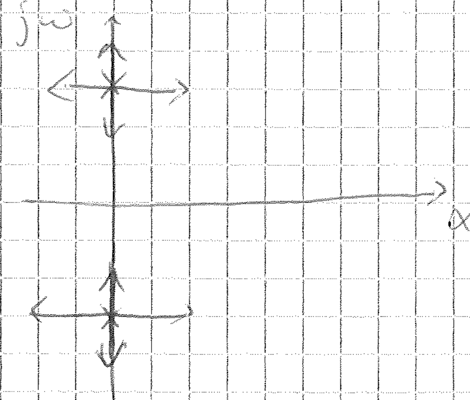

$V_i' = V_i$

$-V_i A(s) f(s) = V_i' \qquad A(j\omega) f(j\omega) = -1$

• RUMORE $\longrightarrow f$




• Discorso sulla condizione MATEMATICA di BARKHAUSEN




Variazioni di ampiezza $\Rightarrow$ $\sigma_0 > 0$

Variazioni di fase

si oscilla a $\omega_0$ $\quad \varphi(\omega_0) = \pi$

$$\varphi(\omega_0) \neq \pi$$

$$\varphi(\omega) = \varphi(\omega_0) + \frac{d\varphi}{d\omega}\bigg|_{\omega=\omega_0} (\omega - \omega_0)$$

$\omega_0'$ $\quad \varphi(\omega_0') = \pi$

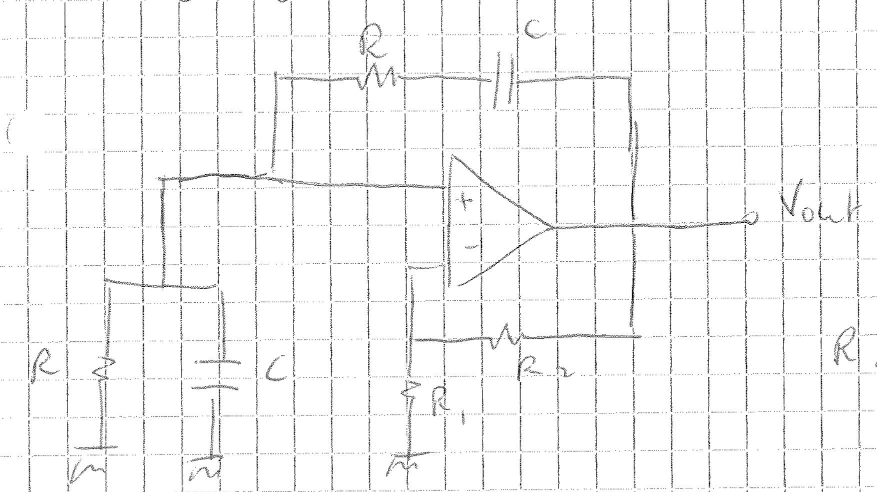
$$\pi = \varphi(\omega_0) + \frac{d\varphi}{d\omega}\bigg|_{\omega=\omega_0} (\omega_0' - \omega_0)$$

$\Delta\varphi = \pi - \varphi(\omega_0)$ $\qquad \Delta\omega = \omega_0' - \omega_0$

$\Delta\varphi = \frac{d\varphi}{d\omega}\bigg|_{\omega=\omega_0} \Delta\omega$ $\qquad S_F = \omega_0 \frac{d\varphi}{d\omega}\bigg|_{\omega=\omega_0} \Rightarrow \Delta\omega = \frac{\Delta\varphi}{S_F}\omega_0$

$S_F \Leftrightarrow Q$

Oscillatore di Wien




$$R \,//\, \frac{1}{sC} = \frac{R}{1+sRC}$$

$$V^+ = V_{out} \cdot \frac{R \,//\, \frac{1}{sC}}{R \,//\, \frac{1}{sC} + R + \frac{1}{sC}} = \frac{\frac{R}{1+sRC}}{\frac{R}{1+sRC} + R + \frac{1}{sC}} =$$

$$= \frac{\frac{R}{1+sRC}}{\frac{RsC + sC(1+sRC)R + 1 + sRC}{(1+sRC)sC}} = \frac{sRC}{3sRC + s^2C^2R^2 + 1} \Rightarrow$$

$$\Rightarrow \cancel{V_{out}} \; \frac{V^+}{V_{out}} = f = \frac{sRC}{s^2R^2C^2 + 3sRC + 1}$$

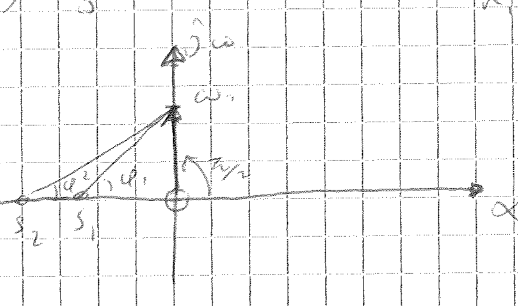
$$A = 1 + \frac{R_2}{R_1}$$

$$\left(1 + \frac{R_2}{R_1}\right) \frac{sRC}{s^2R^2C^2 + 3sRC + 1} = fA = 1$$

$$f(j\omega) = \frac{j\omega RC}{-\omega^2R^2C^2 + 3j\omega RC + 1} \qquad \mathrm{Im}\left[f(j\omega)A(j\omega)\right] = 0$$

$$\omega_0^2 = \frac{1}{R^2C^2} \qquad \omega_0 = \frac{1}{RC} \qquad f(j\omega_0) = \frac{j\omega_0 RC}{3j\omega_0 RC} = \frac{1}{3}$$

$$\left(1 + \frac{R_2}{R_1}\right) \cdot \frac{1}{3} \geq 1 \qquad 1 + \frac{R_2}{R} = 3 + \delta$$




$$s_{1,2} = -\frac{3}{2RC} \pm \frac{1}{2R^2C^2}\sqrt{9R^2C^2 - 4R^2C^2}$$

$$= -\frac{3}{2RC} \pm \frac{\sqrt{5}}{2RC}$$

③

(4)

$$S_F = \omega_0 \frac{d\varphi}{d\omega}\Big|_{\omega=\omega_0}$$

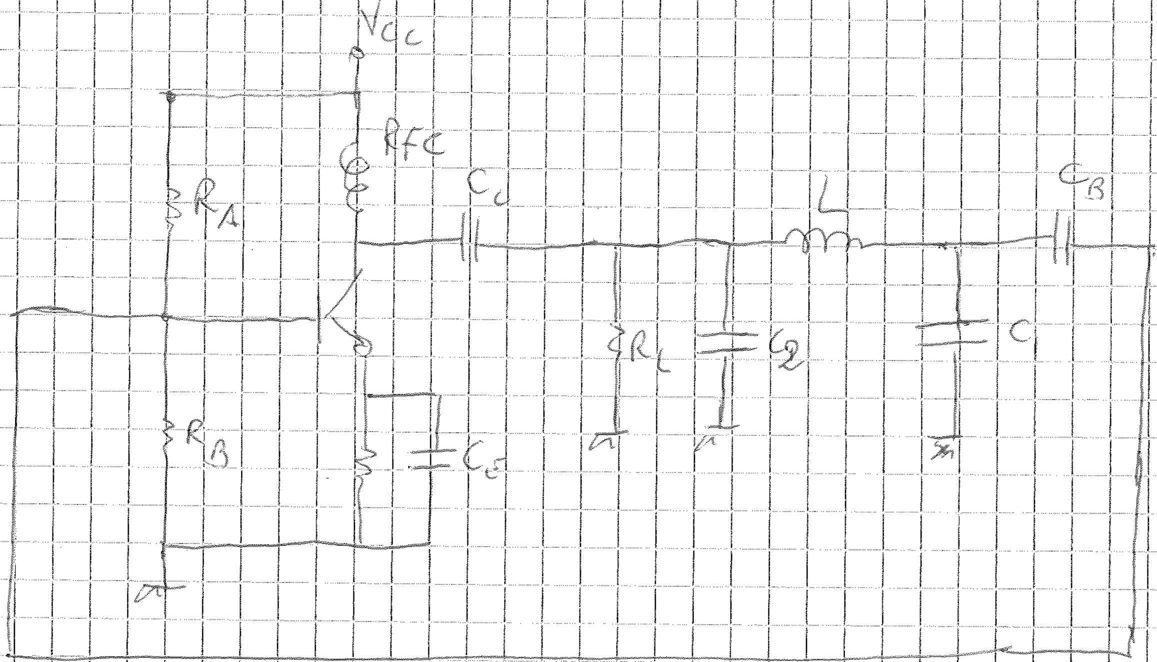
$$\beta(j\omega) = \frac{j\omega RC}{-\omega^2 R^2 C^2 + 3j\omega RC + 1} = \frac{1}{j\omega RC + 3 - \frac{j}{\omega RC}}$$

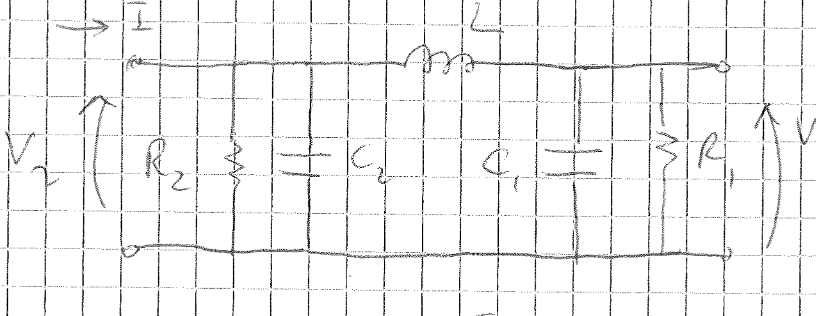
$$\varphi = \angle \beta(j) = \operatorname{arctg} \frac{\omega RC - \frac{1}{\omega RC}}{3}$$

$$\frac{d\varphi}{d\omega} = \frac{1}{1 + \frac{\left(\omega^2 R^2 C^2 - \frac{1}{\omega RC}\right)^2}{9}} \cdot \frac{RC + \frac{1}{\omega^2 RC}}{3}\Bigg|_{\omega=\omega_0} = \frac{2RC}{3}$$

$$S_F = \omega_0 \frac{2}{3} RC = \frac{2}{3}$$

Oscillatori di Colpitts




$$V_1 = -R_2 I \frac{C_2}{C_1}$$

$$R_{in} = R \frac{C_1}{C_2}$$

$C_1 >> C_2$

(4)

$R_2 = R_L$ $\quad R_1 = R_A // R_B // R_\pi$ $\quad \omega_0 = \frac{1}{\sqrt{L(C_1 // C_2)}}$

$I = -g_m v_{BE}$ $\quad V_1 = + g_m v_{BE} \cdot R_L \frac{C_2}{C_1} = v_{BE}$

$g_m R_L \frac{C_2}{C_1} = 1$ $\quad g_m = \frac{C_1}{C_2} \frac{1}{R_L}$ $\quad I_C = \frac{C_1}{C_2} \frac{V_T}{R_L}$